

TUNA: Pole-and-Line Fishing Trials In Central and Western Pacific

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The growing interest of the U.S. tuna fishing industry in the development of resources outside the Inter-American Tropical Tuna Commission's regulatory area in the eastern Pacific created an urgent need to assess the tuna-harvesting potential of the central and western Pacific Ocean.

This article presents quantitative baiting and fishing data obtained aboard the Honolulu-based pole-and-line fishing vessel 'Anela'. The vessel explored the possibility of developing commercial fisheries for surface schooling tuna in the Marshalls and American Samoa under a charter of the National Marine Fisheries Service (NMFS).

Anela found the tuna resources in the Marshalls and American Samoa impressive. Bait was plentiful in the Marshalls but scarce in American and Western Samoa. To conduct fishing trials in American Samoan waters, Anela caught bait in Fiji. Both tuna and bait were abundant around Fiji.

The M/V Anela was built in 1971 for the Angel Fishing Company of Honolulu. It was designed for pole-and-line fishing with live bait. It prospected for tuna from February 8 to May 9, 1972, in the central and western tropical Pacific--more particularly in waters of the Marshall Islands and American Samoa.

Anela was chartered by NMFS Southwest Fisheries Center, Honolulu Laboratory, under a formal contract with the Angel Fishing Company. Its mission was to explore the possibility of developing commercial pole-and-line fisheries for skipjack tuna, *Katsuwonus pelamis*, in the Marshalls and American Samoa. These two areas have been under consideration as potential bases for skipjack fishery development by the PIDC (Pacific Islands Development Commission). The Commission consists of the chief executives of the Governments of Hawaii, American Samoa, Guam, and the Trust Territory of the Pacific Islands. It was formed for cooperative economic development.

The contract stipulated that 20 fishing and baiting days be expended in the Marshalls--10 days (or fewer if a full catch load was obtained in less time) on the outward leg of the cruise, and the balance on the homeward leg. The remaining fishing and baiting time was to be used near American Samoa. Time was allowed for traveling to and from the areas of operation, unloading the catch, loading provisions, and refueling. Allowance also was made for days the vessel could not fish because of bad weather.

The contract stated that observers from NMFS the Marshall Islands District of the Trust Territory, and the Government of American Samoa were to be accommodated on the vessel.

ANELA'S SPECIFICATIONS

Anela is the most recent addition to the Hawaii skipjack fishing fleet (Fig. 1). Propelled by an 850-hp Caterpillar¹ D398 engine,

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¹Use of trade names throughout this article does not imply endorsement by the National Marine Fisheries Service.

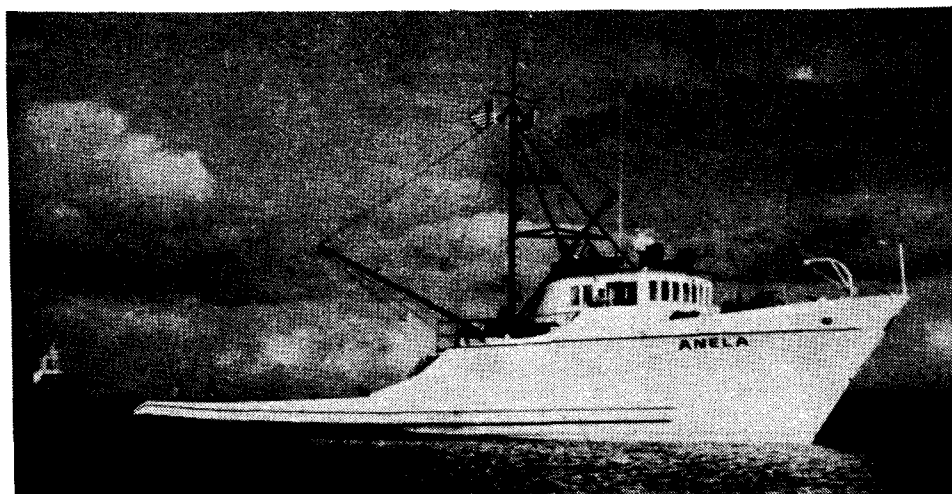


Fig. 1 - 'Anela' anchored in Majuro Lagoon, Marshall Islands.

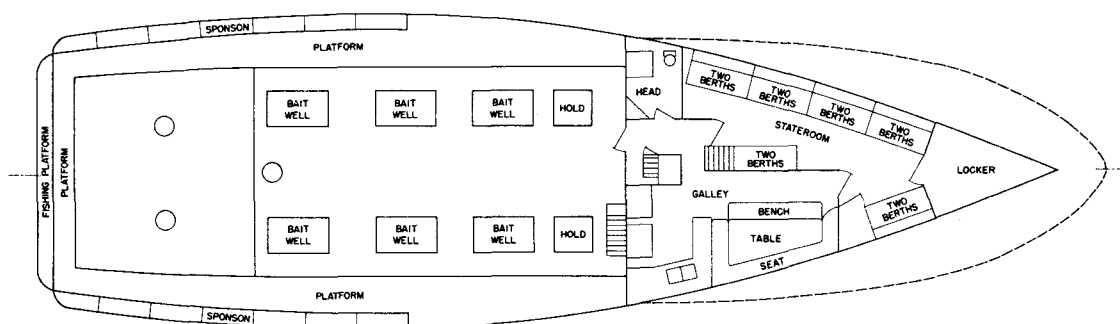


Fig. 2 - Main deck arrangement of 'Anela.'

the steel-hulled vessel has a cruising speed of 13.8 knots and a cruising range of 3,700 km. The registered length is 26.6 m., the beam 7.6 m., and the depth 3.6 m. Gross and net tonnages are 136 and 91 M.T., respectively. The vessel has a fuel-oil capacity of 56,775 liters and freshwater capacity of 11,355 liters.

Figure 2 shows Anela's deck arrangement. The six baitwells, equipped with pump-circulating systems, can hold as much as 160 buckets of bait. When emptied of bait, the baitwells serve as refrigerated fishholds with a fish-carrying capacity of about 77 M.T. Two forward holds are used to store provisions.

MARSHALL ISLANDS (FEB. 16-29)

Departing on the outward leg from Honolulu on February 8, Anela first stopped at Majuro in the Marshall Islands. These islands lie

3,700 km southwest of the Hawaiian Islands on a northwest-southeast axis from lat 15° to 5° N between long 162° and 173° E. The Marshalls make up one of six districts in the Trust Territory of the Pacific Islands, which is administered by the U.S. Department of Interior through a high commissioner headquartered at Saipan. The other districts are Palau, Yap, Truk, Ponape, and the Mariana Islands.

Rising not more than a few meters above sea level, the Marshalls consist of a double chain of coral atolls about 200 km apart. They have a total land area of about 180 km² and a lagoon area of about 11,650 km² (Mason, 1951). The chief island is Jaluit; along with several other islands in the Mariana and Caroline groups, it served as a base for Japanese pole-and-line skipjack fisheries prior to World War II. The present district administrative center is on Majuro, which has good accommodations for shipping (Tudor, 1968).

Baiting

Majuro has an irregularly oval lagoon that measures about 45 km long and 17 km wide (Fig. 3). Exploratory cruises of the NMFS 'Townsend Cromwell' had revealed that bait suitable for pole-and-line fishing was abundant at Majuro. Prior to baiting in Majuro Lagoon, we surveyed the lagoon side of the northern islets where schools of silverside, *Pranesus pinguis*, and sardine, *Herklotsichthys punctatus*, were reported to be abundant (Hida, 1971). Fair-to-good quantities of both species were seen schooled close to shore in shallow water, some over fairly good seining bottom, and some over rough, uneven bottom of coral sands and rubble interspersed with coral heads.

observation by an NMFS observer revealed that when the silverside were schooled in the same location as the sardine, the former always concentrated closer to the surface with the latter below.

Silverside and sardine, although considered by the crew to be inferior to the Hawaiian nehu, *Stolephorus purpureus*, as bait for skipjack fishing, nevertheless were satisfactory as tuna bait. Both species were vigorous in the seine and could be transferred from the seine to the baitwells and "crowded" (concentrated into a small, two-handled push net during chumming) without significant mortalities. Being hardy fish, silverside and sardine could be transported long distances without serious loss. For example, on the 6-day, 2,965-km

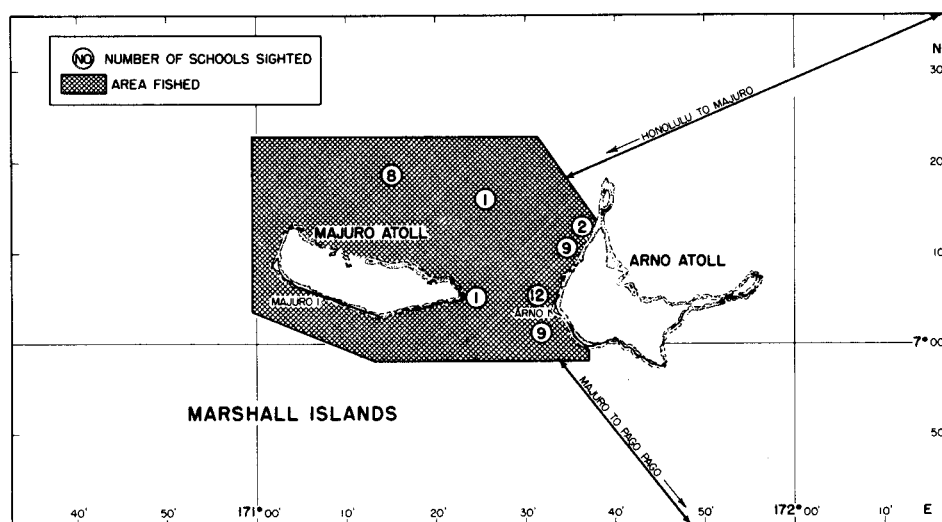


Fig. 3 - Number of schools sighted and the area fished by M/V 'Anela' in the Marshall Islands (February).

On our first stop in the Marshalls, the crew baited twice in Majuro Lagoon and caught 205 buckets of bait in five sets, which required 3.3 hr to complete. One bucket equals 3.2 kg of baitfish. The average catch rates were 62.1 buckets per hour and 41.0 buckets per set; these were far better than those calculated in a June-August 1967 study of Hawaiian skipjack vessels, whose crews averaged only 11.9 buckets per hour and 12.4 buckets per set. A large proportion of the Majuro baitfish was silverside, which ranged from 6.4 to 8.9 cm in total length. Smaller quantities of sardine, taken together with the silverside, ranged from 11.0 to 14.0 cm (T. Hida, personal communication). Underwater

voyage from the Marshalls to American Samoa, Anela carried about 50 buckets of bait with hardly any mortalities. While being transported, the bait were fed daily on a wet mixture of flaked, boiled skipjack and bread.

Fishing

While in the Marshalls in February, we concentrated our effort in waters immediately adjacent to Majuro and Arno atolls (See map). In 7 days of scouting and fishing, we sighted 42 schools, or an average of 6.0 schools per day. This was slightly better than the Hawaiian

vessels' average of 5.4 schools per day in June-August 1967 (Uchida and Sumida, 1971).

Of the 42 schools sighted, we identified 24: 18 skipjack, 3 mixed skipjack-yellowfin *Thunnus albacares*, 1 mixed skipjack-dolphin, *Coryphaena hippurus*, 1 rainbow runner, *Elagatis bipinnulatus*, and 1 mixed rainbow runner-skipjack-yellowfin-kawakawa, *Euthynnus affinis*. Eighteen schools were unidentified. All schools were found under bird flocks, which varied from 5 to over 1,000 birds. The flocks were composed predominantly of noddy terns, *Anous stolidus*, although sooty terns, *Sterna fuscata*, and white terns, *Gygis alba*, were also quite numerous.

Two large flocks of over 1,000 birds were sighted on the day we arrived in the Marshalls. Anela pursued both schools, which were close to shore along the west coast of Arno. Because we had no bait at the time, we used trolling lines and made several passes through the schools but did not catch any fish.

We experienced several days of good fishing despite the inevitable difficulties of fishing in a new region. Figure 4 shows the crew fishing a good-biting skipjack school in the Marshalls. We pursued and chummed 36 of

the 42 schools sighted (86%) and successfully fished 18 (50%) of those chummed. The percentage of schools successfully fished is slightly lower than the 57% success calculated for schools fished in Hawaiian waters (Uchida and Sumida, 1971). We had 2 days when we were unable to catch any fish from the schools fished.

The catch included 3,369 skipjack tuna, 127 yellowfin tuna, 1 kawakawa, 2 rainbow runner, and 1 dolphin. In weight, the catch reached 20.0 M.T. of skipjack and 1.2 M.T. of yellowfin. Catch per day fished (including zero-catch days) was 3.5 M.T. of tuna, slightly higher than the 1967 summer average of 2.8 M.T. calculated for Hawaiian vessels. Ranging from less than 0.1 to 4.4 M.T., catch per school (including zero-catch schools) from 36 schools chummed averaged 0.5 M.T., or half the 1.1 M.T. average of Hawaiian vessels.

By randomly sampling 10 fish from each school fished, we found that the skipjack ranged from 1.6 to 10.6 kg and averaged 5.6 kg. Our data showed that only about 4% of the skipjack landed were less than 4.5 kg. The yellowfin ranged from 5.6 to 13.6 kg and averaged 8.2 kg.

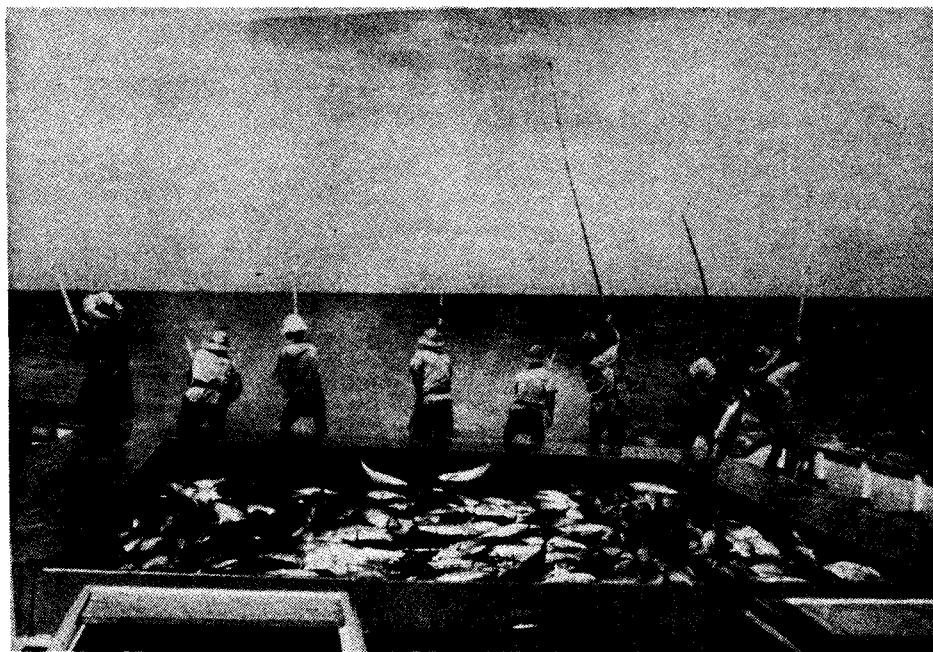


Fig. 4 - The crew of 'Anela' fishing a skipjack school in the Marshalls.

The catch per hook-minute, used here as a measure of the average rate at which fish were caught per hook per minute, ranged from 0.2 to 3.9 fish per hook-minute and averaged 1.1 fish per hook-minute.

Most schools pursued in the Marshalls were "subsurface," where no visible signs of surface movement were detected. We classified the schools as 20 "subsurface," 6 "jumping," and 1 "boiler" (Scott, 1969). Of particular interest was the "boiler" sighted on February 20. When sighted from a distance, the bird flock of over 1,000 was "working" over what appeared to be breakers (Fig. 5). As it turned out, the "boiling" white water was due to hundreds of fish actively pursuing and feeding on prey at the surface. We made 24 passes through this mixed skipjack-yellow-fin school. Seven passes produced no fish. From the remaining 17 passes, the catch varied from 1 to 62 fish. The reason for the small catch on each pass from this large school was that the fish responded to chumming at the stern only for short periods (1 to 11 minutes), then broke off and headed in another direction. The stomach contents of several landed fish, and the regurgitated material on deck, showed that the tuna were

feeding on a small anchovy that closely resembled the Hawaiian nehu.

Environmental Conditions

In February, we had reasonably good weather in the Marshalls. The prevailing northeast trades, estimated from sea conditions to be blowing from 18 to 36 km/hr, were sufficiently strong most of the time to raise whitecaps on the blue water outside the lagoon. High winds and rough seas were responsible for the cancellation of only 2 days of fishing. Showers were frequent but brief and did not seriously hinder baiting or fishing.

From expendable bathythermograph (XBT) casts down to 400 m, we obtained data to construct frequency distributions of surface and subsurface temperatures at 100-m intervals (Fig. 6). Surface temperatures around Majuro and Arno were relatively warm with a narrow range from 27.5° to 28.5° C. At 100 m, the temperatures had a relatively wide range--from 21.3° to 27.0° C; but below that, they varied only slightly--ranges from 11.3° to 13.0° C at 200 m, 9.4° to 9.8° C at 300 m, and 8.6° to 8.9° at 400 m. The thermocline was distinct and occurred between 60 and 102 m.

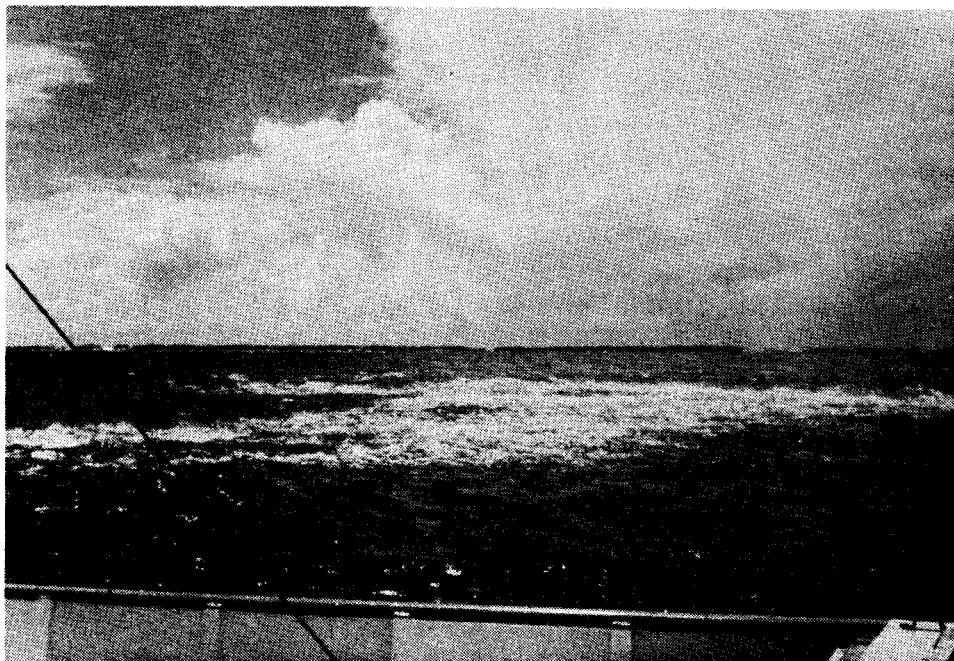


Fig. 5 - A "boiler" school fished off Majuro atoll on February 20, 1972 by the crew of 'Anela.'

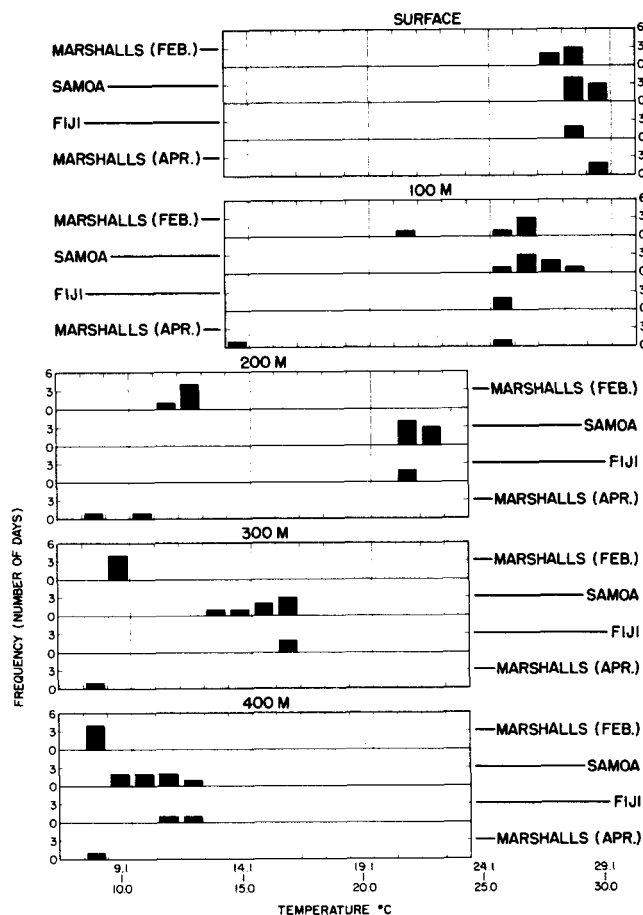


Fig. 6 - Frequency distribution of surface and subsurface temperatures of waters around Marshall Islands (February and April), Samoa, and Fiji, 'Anela' charter cruise, February 8-May 9, 1972.

SAMOA AND FIJI (MARCH 6-APRIL 15)

Anela left the Marshalls on February 29 and arrived at Pago Pago, American Samoa, on March 6. The trip was uneventful except for 1 day of fishing 74 km north-northeast of Apia, Western Samoa, on March 5.

American and Western Samoa are situated between lat 13° and 15° S and extend in an east-west direction from about long 168° to 173° W. They are volcanic in origin (Fig. 7). American Samoa comprises all the islands lying east of long 171° W and is administered by the United States. Pago Pago, on Tutuila, is the principal town and the harbor serves as a port of landing for foreign longline fishing vessels which supply the two American

canneries with large, deep-swimming tunas. Western Samoa is a self-governing nation of the British Commonwealth. It has two large, main islands--Upolu and Savaii. The chief town and administrative center is Apia on Upolu.

Lying 925 km southwest of Samoa is Fiji. It comprises 320 islands of various sizes between lat 15° and 22° S and long 177° W and 175° E (Fig. 8). Two of the largest are Vanua Levu and Viti Levu, on which Suva, present capital, is located. Levuka, the former capital on Ovalau, serves as a port of landing for foreign longline fishing vessels. These unload frozen tuna for transshipment to canneries in the United States and Japan.

Baiting

American Samoa--Previous bait surveys by the NMFS 'Charles H. Gilbert' indicated that bait might be scarce in both American and Western Samoa (Hida, 1970). We spent 3 days looking for bait in American Samoa. We scouted from shore along the beaches of Pala Lagoon and Fagaitua Bay on Tutuila, and from the skiff along the perimeter of Pago Pago Harbor. We saw small schools of juvenile bigeye scad, *Trachurus crumenophthalmus*, along the beaches and sardine, jack, *Caranx* sp., and mullet, *Mugil* sp., in the harbor, but nowhere did we see baitfish in any quantity. We tried fishing with a 100-w light at night, but the amount of juvenile jack and bigeye scad that congregated around the light was hardly sufficient for tuna fishing by a vessel of Anela's size. We also attempted to scout Aoa, Masefau, Afono, Vatia, and Fagasa Bays, but rough seas prevented Anela from launching the skiff. Bait could not be found in American Samoa, so we decided to attempt baiting in Western Samoa.

Western Samoa--On March 10, we departed Pago Pago Harbor and arrived at Apia Harbor (Fig. 7). We scouted intensively along harbor's perimeter and along northwestern shore near harbor's entrance. With exception of a small school of round herring, *Spratelloides delicatulus*,

there were no other baitfish in appreciable quantity. Then we traveled to Asau Harbor on the northern coast of Savaii. There the crew scouted the harbor's perimeter without finding any bait. A night light was also set in an attempt to attract anchovy, which were reported to be in the harbor at times. Again, with the exception of a few jack and bigeye scad, we failed to attract any appreciable quantities of baitfish. Palauli Bay on the southern coast of Savaii also was suggested as a possible baiting ground. But the bay was very shallow and there was no assurance that bait could be found there, so we returned to Pago Pago on March 13. We arranged to depart for Fiji to catch bait. The lack of bait in Samoan waters was in marked contrast to the abundance of bait in Majuro Lagoon.

Fiji--The charter did not include operations near Fiji. However, because bait was lacking in Samoa, we obtained permission from the Government of Fiji to bait in Fijian waters; in return, we agreed to conduct a survey of tuna schools around Fiji. We departed Pago Pago on March 16 and arrived in Suva on March 20.

Runoff from a recent heavy rain had muddied much of the water in baiting grounds near Suva. Therefore, we traveled to Kia Island

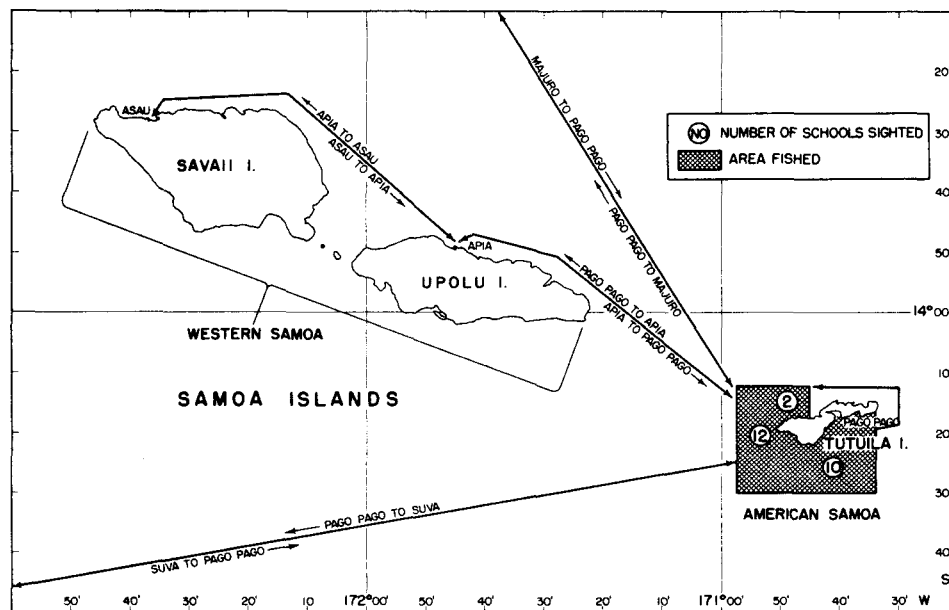


Fig. 7 - Number of schools sighted and the area fished by M/V 'Anela' in American and Western Samoa.

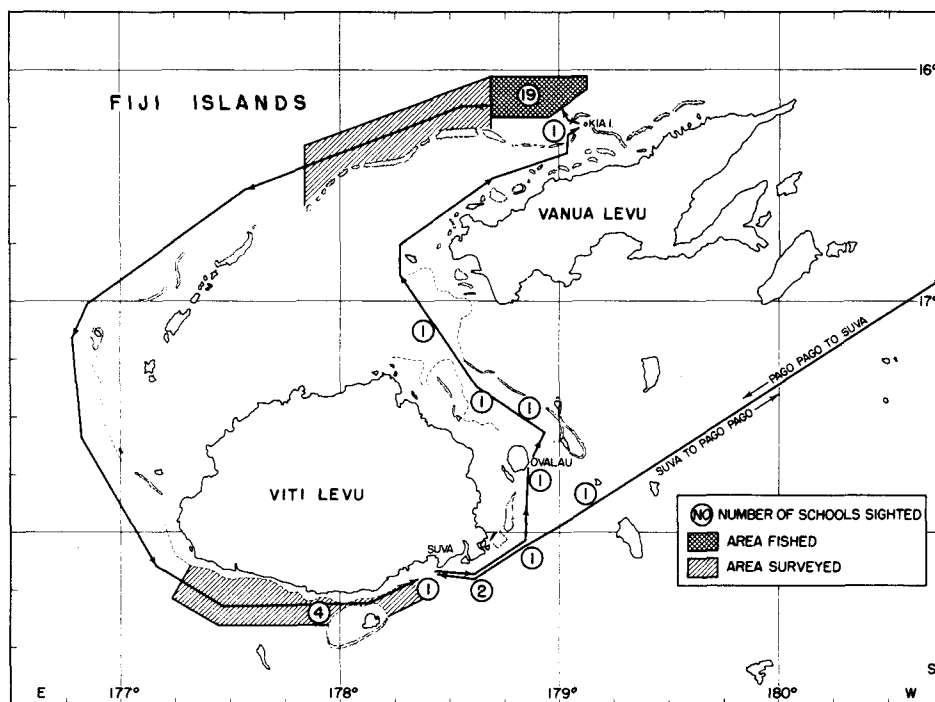


Fig. 8 - Number of schools sighted, area fished, and area surveyed by M/V 'Anela' in Fiji.

north of Vanua Levu and arrived there March 23 (Fig. 8). We surveyed the shoreline and it was immediately obvious that bait was plentiful. We saw bait schooled over rough bottom of jagged rocks and corals, and some over fairly smooth bottom near small, sandy beaches. In the first of two baiting operations, the crew made one set and caught 159 buckets of sardine. After fishing with this bait north of Kia the following day, we returned to the baiting ground. In two sets we caught an additional 110 buckets of sardine and silverside. Sixty buckets were transferred to the baitwells and the remainder released. The crew spent 1.7 hr to catch 269 buckets of bait, an impressive average of 158.2 buckets per hour and 89.7 buckets per set. These were more than double the catch rates calculated for baiting in the Marshalls in February. About 75% of the Kia bait were sardine ranging from 7.6 to 10.2 cm. The smaller silverside were 6.4 to 8.9 cm.

Fishing

American Samoa--Actual fishing time, only 3 days in Samoan waters, was severely limited by the more pressing need to travel

between various baiting sites and by unavoidable delays ashore. We fished near Samoa 2 days with bait caught in the Marshalls.

In 4 days of Samoan scouting, we sighted 25 schools, or an average of 6.2 schools per day. Twenty-three schools were sighted as a result of direct scouting for tuna schools. The remaining two, both skipjack, were sighted north of Tutuila after baiting in the north shore bays was cancelled because of rough seas. Anela trolled through both schools but failed to get a strike.

We identified 16 schools as skipjack and 1 as kawakawa; the remainder was unidentified. Bird flocks over the tuna schools in Samoan waters were usually smaller than those found over tuna schools in the Marshalls. A large proportion of the bird flocks was composed of sooty and noddy terns, but white terns, boobies, and shearwaters also were quite common. Of the 25 schools seen, 21 (84%) were pursued and chummed, but only 8 (38%) of those chummed were successfully fished.

The total catch reached 2,407 skipjack weighing 12.1 M.T. and 33 kawakawa. Catch

per day fished averaged 4.0 M.T., slightly higher than that calculated for fishing in the Marshalls. Catch per school ranged from 0.2 to 3.7 M.T. and averaged 0.5 M.T. About half the Samoan schools were "subsurface"; the remainder was "jumping".

Compared with Marshalls skipjack, Samoan were usually smaller; about half (56%) were under 4.5 kg. Samoan skipjack ranged from 2.3 to 11.6 kg and averaged 5.3 kg.

The catch rates of schools fished in Samoa did not vary as widely as those calculated for schools fished in the Marshalls in February. They ranged from 0.2 to 2.0 fish per hook-minute, and averaged 0.9 fish per hook-minute. This was slightly below February average in the Marshalls.

Fiji--Tuna schools were numerous in Fijian waters. We sighted 3 schools en route to Suva, 8 schools en route to baiting ground at Kia Island, 19 schools in 2 days of fishing north of Kia, 4 schools at Mbengga Passage while returning to Suva, and 2 schools immediately after departing Suva for Pago Pago. Seventeen schools were identified as skipjack, the remainder unidentified.

Most flocks sighted in Fiji were large: 56% were composed of an estimated 101-500 birds. Noddy terns predominated in all flocks, although shearwaters and tropic birds were common in some flocks.

We sighted a daily average of 5.1 schools during scouting and fishing in Fiji. Eighteen (50%) of the schools sighted were pursued, and 16 (84%) of those pursued were chummed. Twelve schools, or 75%, of those chummed yielded fish, a percentage of success much higher than that calculated for schools fished in Hawaii, the Marshalls, and Samoa. The catch reached 6,227 skipjack, or 19.1 M.T., with catch per day fished averaging an impressive 9.6 M.T. This was more than twice the average catch per day in Samoa. Catch per school ranged from less than 0.1 to 3.8 M.T. and averaged 1.1 M.T. This was identical with that calculated for Hawaiian vessels--but twice the average catch from schools fished in the Marshalls and Samoa.

Ranging from 1.2 to 4.5 kg, and averaging only 2.9 kg, the skipjack caught near Fiji were considerably smaller than the fish caught in the Marshalls and Samoa. The small size was offset, in part, by high catch

rates. These varied from 0.1 to 4.4 fish per hook-minute, and averaged 2.3 fish per hook-minute. We obtained good tonnages from most schools fished.

Environmental Conditions

In Samoan waters, Anela found reasonably good weather. Only one baiting attempt and 1 day's fishing were cancelled because of high winds and rough seas. The prevailing east or southeast winds blew at estimated speeds of 18 to 36 km per hour. Showers were frequent and varied from light to heavy, but these did not seriously hinder baiting or fishing. Around Fiji, the winds were either easterly or westerly, and blew from 9 to 28 km per hour. Frequent showers also were a feature of Fiji.

The surface temperatures around Samoa and Fiji were usually warmer than around the Marshalls; they ranged from 28.4° to 29.4° C. Expendable bathythermograph casts showed that the thermocline in the Samoa-Fiji area was rather indistinct; it varied from 43 to 96 m. At 100 m., the temperatures ranged from 27.5° to 28.5° C. At 200 m and below, the temperatures were considerably warmer than at similar depths around the Marshalls. They ranged from 21.2° to 22.8° C at 200 m, 14.0° to 17.0° C at 300 m, and 9.3° to 12.2° C at 400 m (Fig. 7).

MARSHALL ISLANDS (APRIL 23-MAY 2)

On the homeward leg, Anela retraced her path to the Marshalls. It departed Pago Pago on April 16 and arrived in Majuro on April 23 (Fig. 9). We felt it desirable to explore atolls other than Majuro and Arno for concentrations of tuna. We centered our efforts around Jaluit atoll and Kili Island and shifted to Majuro and Arno atolls before returning to Honolulu.

Baiting

Fishing rights in the Marshalls are controlled by local municipalities, the basic units of government on each island or atoll. Before proceeding to Jaluit to bait, we obtained permission from the district administrator in Majuro, who arranged for Anela to bait in Jaluit. Jaluit Lagoon is more than twice the size of Majuro Lagoon; it is 56 km long and 22 km wide (Fig. 9). After fishing near Jaluit and Kili, we returned to Majuro Lagoon to catch bait. Unlike February's baiting con-

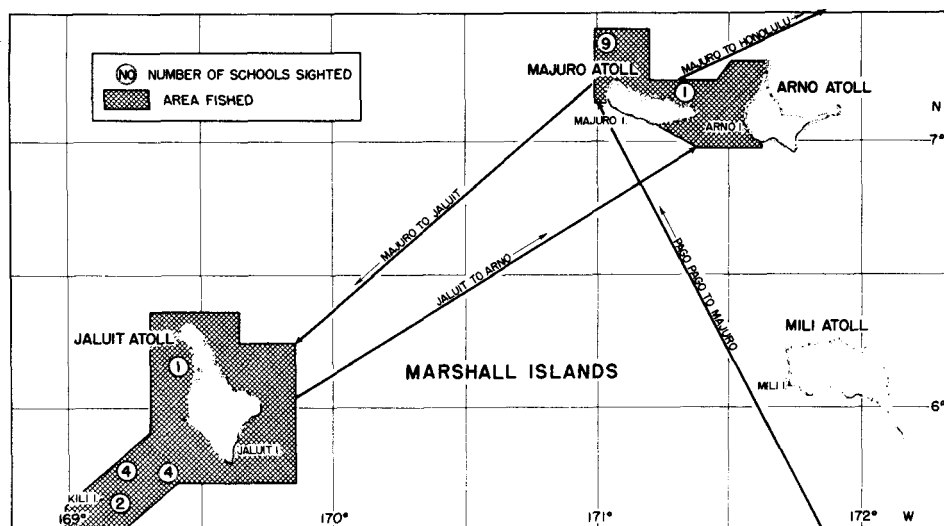


Fig. 9 - Number of schools sighted and area fished by M/V 'Anela' in the Marshall Islands (April).

ditions, we saw none along the shoreline. High winds and rain made visual scouting from the skiff extremely difficult and were partly responsible for our failure to see baitfish schools.

Overall, baiting at Jaluit and Majuro required 3.6 hr. In two sets in Jaluit Lagoon, the catch totaled 189 buckets, an average of 94.5 buckets per set. Catch per hour, which includes the Majuro effort, was 52.5 buckets. After filling baitwells, about 30 buckets of bait remaining in the seine were released. The catch was made on the lagoonside of the shoreline of Emidji island over relatively smooth sand bottom; it consisted almost entirely of sardine ranging from about 8.9 to 11.4 cm long.

Fishing

In April, Anela found Marshalls' conditions considerably changed. Perhaps most significant was size of bird flocks. In February, nearly half the flocks had more than 500 birds; in April, all flocks had 500 birds or fewer. However, there was no change in species composition: predominantly noddy terns, with few sooty and white terns. School sightings in April totaled 23 schools in 4 days, or an average of 5.8 schools per day. Of these, seven were skipjack, eight yellowfin, one mixed skipjack-yellowfin, and seven unidentified.

Ten of the schools sighted were pursued and chummed. Of these, only three (30%) were successfully fished, a rate considerably below February's. There were 3 zero-catch days in 4 days of fishing.

The crew caught 300 fish totaling 2.0 M.T. from two schools of skipjack. One school of yellowfin yielded 44 fish, which weighed 0.6 M.T. The catch per day was very low, averaging only 0.6 M.T., or about one-sixth average catch per day in February. Catch per school was similarly low; it ranged from 0.6 to 1.0 M.T. and averaged only 0.3 M.T.

Although a large proportion of schools pursued in February was "subsurface," the majority of schools pursued in April were "jumping." We had seven "jumping" schools, two "subsurface," and one "finning".

The size of skipjack caught in April did not vary as widely as in February. The April fish were medium-sized--between 5.9 and 7.5 kg and averaging 6.7 kg. For the one yellowfin school fished, the size range was 12.2 to 18.0 kg and the average 14.4 kg; this was considerably larger than February's average size of yellowfin. The catch rates calculated for the three schools fished in April varied between 0.3 and 0.5 fish per hook-minute, and averaged only 0.4 fish per hook-minute. The figure was less than half the catch rate of the February schools.

Environmental Conditions

On homeward leg, changes were evident in environmental conditions. Our weather observations showed that in April the north-east trades had diminished, and the winds had shifted to the east and southeast. The weather was exceptionally mild. Wind speeds were estimated at 9 to 28 km per hour but more frequently at lower speeds.

Surface temperatures, which ranged between 27.5° and 28.5° C in February, were slightly higher at 29.1° and 29.2° C in April. Very noticeable changes had occurred in subsurface layers, particularly in the depth to the top of the thermocline and in the temperature at 200 m (Fig. 6).

CONCLUSIONS

We believe that a commercial pole-and-line fishery for surface schooling skipjack and yellowfin tuna could become a reality and a source of revenue in the Marshall Islands. Not only were the potentials of the skipjack tuna resources impressive, but so were the potentials of the bait resource. The seasonal availability of tuna schools is not yet clearly understood and further studies are necessary. Likewise, stocks of sardine and silverside in the Marshalls need to be studied to determine how well they will withstand fishing pressure by commercial pole-and-line vessels.

Concerning American Samoa, we believe that it is premature to reach conclusions regarding a pole-and-line fishery there. Our limited observations and a previous NMFS survey of Samoan waters have shown that skipjack are present in sufficient quantities to support a commercial fishery at least large enough to meet all local demands. A vital prerequisite is the means of catching the tuna. Bait is scarce, but its seasonal distribution and abundance should be studied further.

We can conclude, tentatively, from our short stop in Fiji that skipjack schools, sighted at rate of 9.5 schools per day north of Kia Island, occur in sufficient numbers to support a small commercial fishery. But the short survey precludes conclusions about the abundance in other areas or in other times of the year in Fiji. Bait appears plentiful. From our observations and conversations with Fijian government observers, it is evident that many species of bait occur around the numerous islands of the Fiji group, and that day and night baiting are possible.

Tuna schools were found relatively close to all island groups surveyed. So a profitable tuna fishery in the Marshalls, Samoa, and Fiji could be based on small vessels of limited bait capacity and cruising range, such as those in Hawaiian waters. Shoreside support facilities for servicing the vessels and processing the catch are already well established in American Samoa and Fiji. Both service foreign longline vessels. The Marshalls, however, lack all such facilities.

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LITERATURE CITED

- HIDA, THOMAS S.
1970. Surface tuna-school fishing & baiting around Samoa Islands. *Commer. Fish. Rev.* 32 (12): 37-41. (Also reprint 896.)
1971. Baitfish scouting in the Trust Territory. *Commercial Fish. Rev.* 33 (11-12): 31-33. (Also reprint 925.)
- MASON, LEONARD
1951. Micronesia: Marshalls, Gilberts, Ocean Island, and Nauru. In Otis W. Freeman (editor), *Geography of the Pacific*, p. 270-297. John Wiley Sons, N.Y., and Chapman Hall, London.
- SCOTT, JAMES MICHAEL
1969. Tuna schooling terminology. *Calif. Fish Game* 55 (2): 136-140.
- TUDOR, JUDY (editor)
1968. Pacific Islands year book and who's who. U.S. Trust Territory of Micronesia, p. 240-263. (10th ed.) Pacific Publications, Technipress House, Sydney, NSW.
- UCHIDA, RICHARD N. and SUMIDA, RAY F.
1971. Analysis of the operations of seven Hawaiian skipjack tuna fishing vessels, June-August 1967. U.S. Nat. Mar. Fish. Serv., Spec. Sci. Rep. Fish. 629, 25 p.